

CLAIMS:

1. A fluid treatment assembly, comprising:
a plurality of ultraviolet lamps adapted to be immersed in a fluid when
5 the assembly is in use;
a plurality of ballast modules for powering said ultraviolet lamps, each
of said ballast modules having a ballast electrically connected to at least one
ultraviolet lamp for powering said at least one ultraviolet lamp, the ballast
having a resonant circuit with a resonance frequency for generating an
10 alternating voltage source to power said at least one ultraviolet lamp and a
driver circuit with a pulse frequency for supplying the resonant circuit with
pulses of electrical energy;
a frame member having a portion adapted to be immersed in the fluid
when the assembly is in use, the frame member supporting said ultraviolet
15 lamps and said ballast modules; and
an electrical system for receiving electrical energy, which has a voltage
and a current, and providing such to said ballast modules;
wherein the resonance frequency is set in excess of 50 kHz.
- 20 2. The fluid treatment assembly of Claim 1, wherein the resonance
frequency is substantially set in a first range of 50 kHz to 1 MHz.
3. The fluid treatment assembly of Claim 1, wherein the resonance
frequency is substantially set in a first range of 100 kHz to 150 kHz.
- 25 4. The fluid treatment assembly of Claim 1, wherein the resonance
frequency is substantially set in a first range of 200 kHz to 250 kHz
5. The fluid treatment assembly of Claim 2, wherein the power supplied to
30 said at least one ultraviolet lamp decreases the further the pulse frequency
deviates from the resonance frequency and wherein the pulse frequency is

varied substantially within a second range of 50kHz to 1 MHz to control the power supplied to said at least one ultraviolet lamp.

6. The fluid treatment assembly of Claim 3, wherein the power supplied to said at least one ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 150 kHz to 200 kHz to control the power supplied to said at least one ultraviolet lamp.

7. The fluid treatment assembly of Claim 4, wherein the power supplied to said at least one ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 150 kHz to 200 kHz to control the power supplied to said at least one ultraviolet lamp.

8. The fluid treatment assembly of Claim 1, wherein the resonant circuit comprises of a capacitance and an inductance in series.

9. The fluid treatment assembly of Claim 1, further comprising an assembly control unit for controlling said ultraviolet lamps; wherein each of said ballast modules further comprises a control section for controlling the ballast and interfacing with said assembly control unit.

10. The fluid treatment assembly of Claim 9, wherein the control section further comprises a monitor section for monitoring its respective ballast module and said at least one ultraviolet lamp, and reporting to said assembly control unit.

11. The fluid treatment assembly of Claim 1, wherein said ballast modules are removable from the fluid treatment assembly.

12. The fluid treatment assembly of Claim 1, wherein each of said ballast modules further comprises a power factor section to substantially synchronize the voltage and current of the electrical energy as viewed by an electrical energy monitor.

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13. The fluid treatment assembly of Claim 1, wherein the resonance frequency is set at greater than 50 kHz for reduced size of components so that the width of a ballast sleeve of a ballast module is substantially the same as the width of a lamp sleeve of an ultraviolet lamp.

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14. The fluid treatment assembly of Claim 1, wherein said ballast modules are immersed in the fluid for cooling by the fluid.

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15. A ballast for powering at least one ultraviolet lamp with electrical energy, said at least one ultraviolet lamp being for use in a photochemical treatment of a fluid, where the ballast is to be immersed in the fluid for cooling by the fluid, the ballast comprising:

a resonant circuit having a resonance frequency for generating an alternating voltage source to power said at least one ultraviolet lamp; and

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a driver circuit having a pulse frequency for supplying the resonant circuit with pulses of electrical energy;

wherein the resonance frequency is set in excess of 50 kHz.

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16. The ballast of Claim 15, wherein the resonance frequency is substantially set in a first range of 50kHz to 1 MHz.

17. The ballast of Claim 15, wherein the resonance frequency is substantially set in a first range of 100 kHz to 150 kHz.

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18. The ballast of Claim 15, wherein the resonance frequency is substantially set in a first range of 200 kHz to 250 kHz.

19. The ballast of Claim 16, wherein the power supplied to said at least one ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 50kHz to 1 MHz to control the power supplied to said at least one ultraviolet lamp.

20. The ballast of Claim 17, wherein the power supplied to said at least one ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 150 kHz to 200 kHz to control the power supplied to said at least one ultraviolet lamp.

21. The ballast of Claim 18, wherein the power supplied to said at least one ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 150 kHz to 200 kHz to control the power supplied to said at least one ultraviolet lamp.

22. The ballast of Claim 15, wherein the resonant circuit comprises a capacitance and an inductance in series.

23. The ballast of Claim 15, wherein the resonance frequency is set at greater than 50 kHz for reduced size of components so that the width of a ballast sleeve of the ballast is substantially the same as the width of a lamp sleeve of an ultraviolet lamp

24. A ballast module for use in a fluid treatment assembly having a frame to support at least one ultraviolet lamp under the control of an assembly control unit, the ballast module comprising:

a ballast for converting electrical energy to a form suitable to power at least one ultraviolet lamp; and

a control section for interfacing with the assembly control unit and controlling said ballast under direction of the assembly control unit.

25. The ballast module of Claim 24, wherein the ballast comprises:
5 a resonant circuit having a resonance frequency for generating an alternating voltage source to power said at least one ultraviolet lamp;
a driver circuit having a pulse frequency for supplying the resonant circuit with pulses of electrical energy;
wherein the resonance frequency is set in excess of 50 kHz.

26. The ballast module of Claim 25, wherein the resonance frequency is substantially set in a first range of 50kHz to 1 MHz.

27. The ballast module of Claim 25, wherein the resonance frequency is
15 substantially set in a first range of 100 kHz to 150 kHz.

28. The ballast module of Claim 25, wherein the resonance frequency is substantially set in a first range of 200 kHz to 250 kHz.

29. The ballast module of Claim 26, wherein the power supplied to said at
20 least one ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 50kHz to 1 MHz to control the power supplied to said at least one ultraviolet lamp.

30. The ballast module of Claim 27, wherein the power supplied to said at
25 least one ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 150 kHz to 200 kHz to control the
30 power supplied to said at least one ultraviolet lamp.

31. The ballast module of Claim 28, wherein the power supplied to said at least one ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 150 kHz to 200 kHz to control the power supplied to said at least one ultraviolet lamp.

32. The ballast module of Claim 24, further comprising a power factor section to substantially synchronize the voltage and current of the electrical energy as viewed by an electrical energy monitor.

33. The ballast module of Claim 24, further comprising a monitor section for monitoring the ballast module and said at least one ultraviolet lamp, and reporting to said assembly control unit.

34. The ballast module of Claim 25, wherein the resonance frequency is set at greater than 50 kHz for reduced size of components so that the width of a ballast sleeve is substantially the same as the width of a lamp sleeve of said at least one ultraviolet lamp.

35. A method of photochemically treating a fluid using a fluid treatment assembly, comprising
immersing a plurality of ultraviolet lamps in the fluid when the assembly is in use;

powering said ultraviolet lamps using a plurality of ballast modules, each of said ballast modules having a ballast electrically connected to at least one ultraviolet lamp for powering said at least one ultraviolet lamp, the ballast having a resonant circuit with a resonance frequency for generating an alternating voltage source to power said at least one ultraviolet lamp and a driver circuit with a pulse frequency for supplying the resonant circuit with pulses of electrical energy;

supporting said ultraviolet lamps and said ballast modules in a frame member having a portion adapted to be immersed in the fluid when the

assembly is in use; and

receiving electrical energy, which has a voltage and a current, and
providing such to said ballast modules;

wherein the resonance frequency is set in excess of 50 kHz.

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36. The method of Claim 35, wherein the resonance frequency is
substantially set in a first range of 50kHz to 1 MHz.

37. The method of Claim 35, wherein the resonance frequency is
10 substantially set in a first range of 100 kHz to 150 kHz.

38. The method of Claim 35, wherein the resonance frequency is
substantially set in a first range of 200 kHz to 250 kHz

15 39. The method of Claim 36, wherein the power supplied to said at least
one ultraviolet lamp decreases the further the pulse frequency deviates from
the resonance frequency and wherein the pulse frequency is varied
substantially within a second range of 50kHz to 1 MHz to control the power
supplied to said at least one ultraviolet lamp.

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40. The method of Claim 37, wherein the power supplied to said at least
one ultraviolet lamp decreases the further the pulse frequency deviates from
the resonance frequency and wherein the pulse frequency is varied
substantially in a second range of 150 KHz to 200 kHz to control the power
25 supplied to said at least one ultraviolet lamp.

41. The method of Claim 38, wherein the power supplied to said at least
one ultraviolet lamp decreases the further the pulse frequency deviates from
the resonance frequency and wherein the pulse frequency is varied
30 substantially in a second range of 150 KHz to 200 kHz to control the power
supplied to said at least one ultraviolet lamp.

42. The method of Claim 35, wherein the resonant circuit comprises of a capacitance and an inductance in series.

5 43. The method of Claim 35, further comprising monitoring said ballast modules and said ultraviolet lamps.

44. The method of Claim 35, wherein said ballast modules are removable from the fluid treatment assembly.

10 45. The method of Claim 35, further comprising synchronizing the voltage and current of the electrical energy as viewed by an electrical energy monitor.

15 46. The method of Claim 35, wherein the resonance frequency is set at greater than 50 kHz for reduced size of components so that the width of a ballast sleeve of a ballast module is substantially the same as the width of a lamp sleeve of an ultraviolet lamp.

20 47. The method of Claim 35, further comprising immersing said ballast modules in the fluid for cooling by the fluid.

25 48. A method of operating a ballast for powering at least one ultraviolet lamp with electrical energy, said at least one ultraviolet lamp being for use in a photochemical treatment of a fluid, where the ballast is to be immersed in the fluid for cooling by the fluid, the method comprising:

generating an alternating voltage source to power said at least one ultraviolet lamp using a resonant circuit having a resonance frequency; and supplying the resonant circuit with pulses of electrical energy using a driver circuit having a pulse frequency;
30 wherein the resonance frequency is set in excess of 50 kHz.

49. The method of Claim 48, wherein the resonance frequency is substantially set in a first range of 50kHz to 1 MHz.

50. The method of Claim 48, wherein the resonance frequency is substantially set in a first range of 100 kHz to 150 kHz.

51. The method of Claim 48, wherein the resonance frequency is substantially set in a first range of 200 kHz to 250 kHz.

52. The method of Claim 49, wherein the power supplied to said at least one ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 50kHz to 1 MHz to control the power supplied to said at least one ultraviolet lamp.

53. The method of Claim 50, wherein the power supplied to said at least one ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 150 kHz to 200 kHz to control the power supplied to said at least one ultraviolet lamp.

54. The method of Claim 51, wherein the power supplied to said at least one ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 150 kHz to 200 kHz to control the power supplied to said at least one ultraviolet lamp.

55. The method of Claim 48, wherein the resonant circuit comprises of a capacitance and an inductance in series.

56. The method of Claim 48, wherein the resonance frequency is set at greater than 50 kHz for reduced size of components so that the width of a

ballast sleeve of the ballast is substantially the same as the width of a lamp sleeve of an ultraviolet lamp

57. A fluid treatment assembly, comprising:

5 a ultraviolet lamp adapted to be immersed in a fluid when the assembly is in use;

a ballast module for powering said ultraviolet lamp, said ballast module having a ballast electrically connected to said ultraviolet lamp for powering said ultraviolet lamp, the ballast having a resonant circuit with a resonance
10 frequency for generating an alternating voltage source to power said ultraviolet lamp and a driver circuit with a pulse frequency for supplying the resonant circuit with pulses of electrical energy;

a frame member having a portion adapted to be immersed in the fluid when the assembly is in use, the frame member supporting said ultraviolet
15 lamp and said ballast module; and

an electrical system for receiving electrical energy, which has a voltage and a current, and providing such to said ballast module;

wherein the resonance frequency is set in excess of 50 kHz.

20 58. The fluid treatment assembly of Claim 57, wherein the resonance frequency is substantially set in a first range of 50kHz to 1 MHz.

59. The fluid treatment assembly of Claim 57, wherein the resonance frequency is substantially set in a first range of 100 kHz to 150 kHz.

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60. The fluid treatment assembly of Claim 57, wherein the resonance frequency is substantially set in a first range of 200 kHz to 250 kHz

61. The fluid treatment assembly of Claim 58, wherein the power supplied
30 to said ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied

substantially within a second range of 50kHz to 1 MHz to control the power supplied to said ultraviolet lamp.

62. The fluid treatment assembly of Claim 59, wherein the power supplied to said ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 150 kHz to 200 kHz to control the power supplied to said ultraviolet lamp.

63. The fluid treatment assembly of Claim 60, wherein the power supplied to said ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 150 kHz to 200 kHz to control the power supplied to said ultraviolet lamp.

64. The fluid treatment assembly of Claim 57, wherein the resonant circuit comprises of a capacitance and an inductance in series.

65. The fluid treatment assembly of Claim 57, further comprising an assembly control unit for controlling said ultraviolet lamp; wherein said ballast module further comprises a control section for controlling the ballast and interfacing with said assembly control unit.

66. The fluid treatment assembly of Claim 65, wherein the control section further comprises a monitor section for monitoring said ballast module and said ultraviolet lamp, and reporting to said assembly control unit.

67. The fluid treatment assembly of Claim 57, wherein said ballast module is removable from the fluid treatment assembly.

68. The fluid treatment assembly of Claim 57, wherein said ballast module further comprises a power factor section to substantially synchronize the

voltage and current of the electrical energy as viewed by an electrical energy monitor.

69. The fluid treatment assembly of Claim 57, wherein the resonance
5 frequency is set at greater than 50 kHz for reduced size of components so
that the width of a ballast sleeve of a ballast module is substantially the same
as the width of a lamp sleeve of said ultraviolet lamp.

70. The fluid treatment assembly of Claim 57, wherein said ballast module
10 is immersed in the fluid for cooling by the fluid.

71. A method of photochemically treating a fluid using a fluid treatment
assembly, comprising
immersing an ultraviolet lamp in the fluid when the assembly is in use;
15 powering said ultraviolet lamp using a ballast module, said ballast
module having a ballast electrically connected to said ultraviolet lamp for
powering said ultraviolet lamp, the ballast having a resonant circuit with a
resonance frequency for generating an alternating voltage source to power
said ultraviolet lamp and a driver circuit with a pulse frequency for supplying
20 the resonant circuit with pulses of electrical energy;
supporting said ultraviolet lamp and said ballast module in a frame
member having a portion adapted to be immersed in the fluid when the
assembly is in use; and
receiving electrical energy, which has a voltage and a current, and
25 providing such to said ballast module;
wherein the resonance frequency is set in excess of 50 kHz.

72. The method of Claim 71, wherein the resonance frequency is
substantially set in a first range of 50kHz to 1 MHz.

73. The method of Claim 71, wherein the resonance frequency is
substantially set in a first range of 100 kHz to 150 kHz.

74. The method of Claim 71, wherein the resonance frequency is substantially set in a first range of 200 kHz to 250 kHz

5 75. The method of Claim 72, wherein the power supplied to said ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially within a second range of 50kHz to 1 MHz to control the power supplied to said ultraviolet lamp.

10 76. The method of Claim 73, wherein the power supplied to said ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially in a second range of 150 kHz to 200 kHz to control the power supplied to said at least one
15 ultraviolet lamp.

20 77. The method of Claim 74, wherein the power supplied to said ultraviolet lamp decreases the further the pulse frequency deviates from the resonance frequency and wherein the pulse frequency is varied substantially in a second range of 150 kHz to 200 kHz to control the power supplied to said at least one ultraviolet lamp.

25 78. The method of Claim 71, wherein the resonant circuit comprises of a capacitance and an inductance in series.

79. The method of Claim 71, further comprising monitoring said ballast module and said ultraviolet lamp.

30 80. The method of Claim 71, wherein said ballast module is removable from the fluid treatment assembly.

81. The method of Claim 71, further comprising

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